THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today (1) was not written for publication in a law journal and (2) is not binding precedent of the Board.

Paper No. 18

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte JOHN F. CURRIE
and CHETLUR S. SUNDARARAMAN

Appeal No. 96-3105
Application 08/135,003[1]

ON BRIEF

Before KRASS, BARRETT, and BARRY, Administrative Patent Judges.

BARRETT, Administrative Patent Judge.

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[1] Application for patent filed October 12, 1993, entitled "Field Effect Devices."

DECISION ON APPEAL

This is a decision on appeal under 35 U.S.C. § 134 from the final rejection of claims 1-3, 5-19, and 30-36.

We reverse.

BACKGROUND

The disclosed invention is directed to a field effect transistor (FET) device wherein part of the channel near the source region is graded by varying the composition in a linear fashion (see region 62 of the channel in figure 4). This creates a built-in quasi-electric field in the near source region that accelerates charge carriers entering the channel region from the source to velocity saturation. "The velocity saturated hot carriers can travel the channel region ballistically and reduce the channel transit time resulting in faster switching." (Specification, page 20, lines 28-30, as amended.)

Claim 1 is reproduced below.

1. A FET device, comprising:

a source region;

a drain region;

a channel region interconnecting said source region and said drain region, and provided under a gate;

> said channel region comprising adjacent said source region a first portion having at least one of a higher bandgap energy and a lower electron affinity than a second portion extending between said first portion to said drain region, whereby
>
> a quasi-electric field in said channel region near said source region is created in order to accelerate charge carriers and increase switching speed.

The examiner relies on appellants' admitted prior art in figures 1-3 and the following prior art references:

Wieder et al. (Wieder)	4,468,851	September 4, 1984
Saunier et al. (Saunier)	4,558,337	December 10, 1985

Claims 1-3, 5-19, 30, 31, and 35-37 stand rejected under 35 U.S.C. § 103 as being unpatentable over the admitted prior art in appellants' figures 1-3 and Wieder.

Claims 20-29 and 32-34 stand rejected under 35 U.S.C. § 103 as being unpatentable over the admitted prior art in appellants' figures 1-3 and Wieder, further in view of Saunier.

We refer to the Final Rejection (Paper No. 6) and the Examiner's Answer (Paper No. 14) (pages referred to as "EA__") for a statement of the examiner's position and to the Appeal Brief (Paper No. 13) (pages referred to as "Br__") for a statement of appellants' arguments thereagainst.

OPINION

The claims are argued to stand or fall together (Br6). The claims will stand or fall together with claim 1, the sole independent claim.

Appellants argue that the examiner errs in finding no structural difference between grading a source region and grading a first portion of a channel region (Br6-7, argument i). The examiner states that he "sees no structural difference between 'grading in the channel near the source' vs. 'grading in the source near the channel'; the result is the same" (EA5). Although there is a structural difference between a channel and a source in terms of doping, we are reluctant to find that the examiner erred in his general statement because where the source ends and the channel begins when grading is present between the source and the channel may not be clear depending upon the circumstances. However, as discussed, infra, we are not persuaded that Wieder discloses grading as claimed.

Appellants argue (Br7): "By merely teaching grading of the source, Wieder does not teach a structure which could be used to improve charge carrier flow between the source and

drain." In view of appellants' later arguments that Wieder is graded transverse to the direction of the channel, (i.e., in a vertical direction), we presume this argument is made assuming, arguendo, that the source in Wieder is graded in the horizontal direction. We are not convinced that grading of the source could not improve charge carrier flow. It is known, for example, that the graded-base region of bipolar transistors creates an electric field that aids the motion of the charge carriers. See S.M. Sze, Semiconductor Devices Physics and Technology, (John Wiley & Sons, 1985), pages 124-25 (copy attached).

Appellants argue that the examiner errs in finding that Wieder is concerned with switching speed and the improved acceleration of charge carriers in the channel region (Br6, Br7-8, argument ii). We agree. Wieder discloses that "inversion mode operation between heterojunction contacts through a p-type ternary alloy epilayer permits faster electron transit" (col. 1, lines 24-26) and "[t]he reasons for using an inversion mode transistor based on the ternary alloy . . . intend to take full advantage of the specific high electron velocity of the $Ga_{0.47}In_{0.53}As$" (col. 4, lines 1-6). The

high electron velocity is due to the ternary alloy, not to any charge acceleration from the source. An important feature is providing heterojunction source and drain contacts (e.g., col. 1, lines 63-66). It can be seen that the benefits in Wieder are achieved with both non-graded (col. 2, line 60 to col. 3, line 13) and graded (col. 3, lines 14-32) heterojunction source and drain contacts. Therefore, we find no indication that grading of the source in Wieder is intended to improve the flow of charge carriers.

Appellants argue that the examiner errs in finding that Wieder results in a grading of the source in the direction of the channel instead of perpendicular to the direction of charge carrier flow in the channel (Br6-7, Br8-9, argument iii). The examiner states (EA4-5):

> Particularly, Wieder provides in column 3 for an InGaAs channel 12 and a graded source region comprising for example a diffused region of GaInAsP into the InP substrate wherein there resides a higher concentration of P away from the source/channel junction than near the source/channel junction (since P is diffused from the [?] as taught in column 3, lines 19-21). Further as taught in column 3 lines 58-63, the source/drain is taught to be lattice matched and of a larger bandgap than the channel. Thus the structure results in Wieder's only Figure which is the same as Appellant's claim 1. See Examiner's graphical Interpretation of Wieder, attached.

We agree with appellants' interpretation of Wieder.

The examiner's explanation of why there is a higher concentration of P away from the source/channel junction is missing. Lines 18-21, which the examiner relies on, discuss that the source and drain contact windows are exposed to a stream of phosphine and hydrogen, which indicates that the chemical reaction will be uniform over the surface of the window. This clearly implies that grading will be into the substrate in a vertical direction and not lateral in a horizontal direction as found by the examiner and shown in the examiner's sketch. The optional heterojunction construction in column 3 does not remove the $Ga_{0.47}In_{0.53}As$ layer 12 over the InP substrate 11 as in the first embodiment of column 2, line 60 to column 3, line 13. Wieder discloses that "[t]he composition of the heterojunction may vary from that of InP through the quaternary alloy $In_xGa_{1-x}As_yP_{1-y}$ up to the ternary alloy $Ga_{0.47}In_{0.53}As$" (col. 3, lines 26-29), which is what would be obtained in a vertical direction by exposing the $Ga_{0.47}In_{0.53}As$ layer 12 over the InP substrate 11 to a stream of phosphorus. Wieder also discloses that "[t]he source and drain heterojunctions optionally are made of other materials which are lattice-matched to $Ga_{0.47}In_{0.53}As$ yet have a larger bandgap"

(col. 3, lines 57-59). This says nothing about grading in the source near the channel region, which the examiner considers the same as grading in the channel near the source. Saunier does not cure this deficiency. We conclude that the examiner has failed to establish a prima facie case of obviousness for the claim limitations of "said channel region comprising adjacent said source region a first portion having at least one of a higher bandgap energy and a lower electron affinity than a second portion extending between said first portion to said drain region, whereby a quasi-electric field in said channel region near said source region is created in order to accelerate charge carriers and increase switching speed." The rejection of claims 1-3, 5-19, and 30-36 is reversed.

REVERSED

ERROL A. KRASS)
Administrative Patent Judge)
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	)	BOARD OF PATENT
LEE E. BARRETT	)	APPEALS
Administrative Patent Judge	)	AND
	)	INTERFERENCES
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LANCE LEONARD BARRY	)	
Administrative Patent Judge	)	

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